CLAIM + DETAILED DESCRIPTION

[Claim(s)]

[Claim 1] The ceramic heater which has the electric supply terminal which made one [which lays a resistance heating element underground] principal surface of the tabular ceramic object the installation side of the sample, and was electrically connected with the above-mentioned resistance heating element in the principal surface of another side, In the sample heating device which consists of a ceramic tubed base material which junction unification is airtightly carried out to the principal surface of another side of said ceramic heater so that the above-mentioned electric supply terminal may be surrounded, and installs the above-mentioned ceramic heater in the vacuum processing interior of a room The sample heating device characterized by engraving an annular groove among the principal surfaces of another side of the above-mentioned ceramic heater along the perimeter edge and/or inner circumference edge of a junction with the above-mentioned ceramic tubed base material.

[Claim 2] The ceramic heater which has the electric supply terminal which made one [which lays a resistance heating element underground] principal surface of the tabular ceramic object the installation side of the sample, and was electrically connected with the above-mentioned resistance heating element in the principal surface of another side, In the sample heating device which consists of a ceramic tubed base material which junction unification is airtightly carried out to the principal surface of another side of said ceramic heater so that the above-mentioned electric supply terminal may be surrounded, and installs the above-mentioned ceramic heater in the vacuum processing interior of a room The sample heating device characterized by having prepared the height in the center of the principal surface of another side of the above-mentioned ceramic heater, and joining the above-mentioned ceramic tubed base material to this height.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the sample heating device heated to various processing temperature where samples, such as a semiconductor wafer, are held in etch apparatus, such as membrane formation equipment, such as Plasma CVD, Decompression CVD, Light CVD, and sputtering, and plasma etching, optical etching.

[0002]

[Description of the Prior Art] In the manufacturing process of a semiconductor device, conventionally Plasma CVD, Decompression CVD, In etch apparatus, such as membrane formation equipment, such as Light CVD and sputtering, and plasma etching, optical etching, in order to heat to various processing temperature, holding the semiconductor wafer (a wafer being called hereafter.) used as a sample, the sample heating device is used.

[0003] For example, 20 is the vacuum processing room equipped with the exhaust air hole 22 for carrying out vacuum suction to the gas supply hole 21 for supplying process gas so that the state where the conventional sample heating device was attached to the vacuum processing interior of a room at drawing 7 may be shown. In this vacuum processing room 20, the sample heating device 31 which consists of a ceramic heater 32 and a ceramic tubed base material 42 is installed. [ceramic heater] while

a nothing up-and-down side consists the shape of a disk of a tabular ceramic object 33 formed smoothly and evenly and this kind of ceramic heater 32 lays the resistance heating element 34 underground into this tabular ceramic object 33 One principal surface is made into the installation side 35 of Wafer W, and the electric supply terminal 36 electrically connected with the above-mentioned resistance heating element 34 is joined by the principal surface of another side. moreover, [the principal surface of another side of the above-mentioned tabular ceramic object 33] Junction unification is carried out to the ceramic tubed base material 42 being also in glass junction so that said electric supply terminal 36 may be surrounded, and the lead 37 connected to the electric supply terminal 36 is taken out out of the vacuum processing room 20 (refer to JP,H4-78138,A).

[0004] And in order to process membrane formation, etching, etc. to Wafer W with this sample heating device 31 First, while changing the inside of the vacuum processing room 20 into a vacuum state, Wafer W is put on the installation side 35 of a ceramic heater 32. Wafer W is heated to the preset temperature of 400 degrees C or more by energizing for the electric supply terminal 36 and making the resistance heating element 34 generate heat. By drawing process gas, such as gas for DEPOJISSHON, and gas for etching, into the vacuum processing room 20 from the gas supply hole 21 in this state, various processings are performed to Wafer W.

[0005]

[Problem to be solved by the invention] However, if a heat cycle is repeatedly added [by generation of heat of the above-mentioned ceramic heater 32] to the sample heating device 31 in [temperature] 400 degrees C or more from a room temperature region (25 degrees C) Since it was hurt in the junction of a ceramic heater 32 and the ceramic tubed base material 42, the degree of vacuum in the vacuum processing room 20 fell, and, as a result, the technical problem that it had a bad influence on membrane formation accuracy or etching accuracy occurred.

[0006] Namely, [it is difficult to really consider it as a thing, to fabricate, to calcinate a ceramic heater 32 and the ceramic tubed base material 42, and to manufacture them, since the sample heating device 31 is large-sized and its structure is complicated, after manufacturing both individually, have joined in one by glass junction but] While a junction interface exists, respectively between a ceramic heater 32, a junction 40, and the ceramic tubed base material 42 and a junction 40 Since the glass with which the heat transfer characteristics differ intervened between the ceramic heater 32 and the ceramic tubed base material 42, the heat stress which it is easy to concentrate heat stress on these junction interfaces, and is added as a result repeatedly was not able to prevent a crack from occurring in a junction 40.

[0007] Moreover, although corrosive high halogen system gas is used in membrane formation equipment or an etch apparatus as the gas for DEPOJISSHON, the gas for etching, or gas for cleaning Since a junction 40 consisted of glass, when it was put to the above-mentioned halogen system gas, while being easy to carry out corrosion wear and being hurt within the short period of time, the technical problem that it had a bad influence on the processing accuracy to Wafer W also had the wear powder generated by this corrosion wear.

[0008] And in glass junction, it could be equal to use only to about at most 400-degree C temperature region, and was not able to respond to processing in the temperature region of 600 degrees C or more demanded in recent years.

[0009]

[Means for solving problem] Then, in view of the above-mentioned technical problem, this invention [the 1st invention] The ceramic heater which has the electric supply terminal which made one [which

lays a resistance heating element underground] principal surface of the tabular ceramic object the installation side of the sample, and was electrically connected with the above-mentioned resistance heating element in the principal surface of another side, In the sample heating device which consists of a ceramic tubed base material which junction unification is airtightly carried out to the principal surface of another side of said ceramic heater so that the above-mentioned electric supply terminal may be surrounded, and installs the above-mentioned ceramic heater in the vacuum processing interior of a room It is characterized by engraving an annular groove among the principal surfaces of another side of the above-mentioned ceramic heater along the perimeter edge and/or inner circumference edge of a junction with the above-mentioned ceramic tubed base material.

[0010] Moreover, the ceramic heater which has the electric supply terminal which the 2nd invention made one [which lays a resistance heating element underground] principal surface of the tabular ceramic object the installation side of the sample, and was electrically connected with the above-mentioned resistance heating element in the principal surface of another side, In the sample heating device which consists of a ceramic tubed base material which junction unification is airtightly carried out to the principal surface of another side of said ceramic heater so that the above-mentioned electric supply terminal may be surrounded, and installs the above-mentioned ceramic heater in the vacuum processing interior of a room The height is prepared in the center of the principal surface of another side of the above-mentioned ceramic heater, and it is characterized by joining the above-mentioned ceramic tubed base material to this height.

[0011]

[Mode for carrying out the invention] The embodiment of this invention is explained hereafter.

[0012] The sectional view showing the state where drawing 1 attached the sample heating device of this invention to the vacuum processing room, the perspective view in which drawing 2 shows only a sample heating device, and drawing 3 are the exploded views of a sample heating device.

[0013] In drawing 1 , 20 is the vacuum processing room equipped with the exhaust air hole 22 for carrying out vacuum suction to the gas supply hole 21 for supplying process gas, and the sample heating device 1 which consists of a ceramic heater 2 and a ceramic tubed base material 12 is installed in this vacuum processing room 20. As shown in drawing 2 , a nothing up-and-down side consists of a smooth tabular ceramic object 3, and depends the shape of a disk also on the size of Wafer W as that size, but what is the outer diameter of 150-350mm and about 8-25mm in thickness can be used for this ceramic heater 2. Moreover, while having laid underground the resistance heating element 4 which consists of metal, such as tungsten, and molybdenum or platinum, into the tabular ceramic object 3 and making one principal surface into the installation side 5 of Wafer W, the electric supply terminal 6 electrically connected with the above-mentioned resistance heating element 4 is joined to the principal surface of another side. In addition, in this invention, a principal surface is the largest surface among the tabular ceramic objects 3, and the principal surface of another side means one principal surface and the surface by the side of opposite.

[0014] Moreover, the temperature detection means 8, such as a thermo couple, are built in the center of the above-mentioned tabular ceramic object 3, and the temperature of the installation side 5 is detected.

[0015] and [the principal surface of another side of the above-mentioned tabular ceramic object 3] The junction unification of the ceramic tubed base material 12 which carried out the shape of a cylinder has been airtightly carried out by sintering so that the lead 9 of the electric supply terminal 6 and the temperature detection means 8 may be surrounded, and the leads 7 and 9 connected to the electric supply

terminal 6 and the temperature detection means 8 are taken out out of the vacuum processing room 20.
[0016] [here] as the tabular ceramic object 3 which constitutes a ceramic heater 2, and a ceramic tubed base material 12 It is precise, it is required to form by heat resistance, corrosion resistance, and Ceramics Sub-Division that was further excellent in plasma-proof nature, and nitriding thing system Ceramics Sub-Division which makes the main ingredients silicon nitride, sialon, alumimium nitride, and nitriding boron as such Ceramics Sub-Division can be used. It is suitable from excelling to corrosive high halogen system gas and plasma while rapid **** is possible for it, since Ceramics Sub-Division which makes alumimium nitride the main ingredients also especially in these has high thermal conductivity as compared with other Ceramics Sub-Division.
[0017] Moreover, the tabular ceramic object 3 and the ceramic tubed base material 12 need to form from a viewpoint which carries out junction unification by sintering by Ceramics Sub-Division [being of the same kind (the main ingredients being the same)], and it is good to form by Ceramics Sub-Division of the same composition preferably. Since both thermal expansion difference can be made very small by this, the heat stress generated in a junction interface can be reduced sharply, and it can stop that a crack occurs in a junction 10.
[0018] in addition, [carry out / by sintering / junction unification] in this invention It says that a junction 10 is also as of the same kind as the tabular ceramic object 3 or the ceramic tubed base material 12, or that consist of Ceramics Sub-Division of the same composition, and the tabular ceramic object 3, the junction 10 and the junction 10, and the ceramic tubed base material 12 are sintered by each. As of the same kind as a method of carrying out junction unification by sintering as Ceramics Sub-Division which constitutes the tabular ceramic object 3 and the ceramic tubed base material 12, or the ceramic paste of the same composition is applied to one of bonded surfaces. [join / it / by the hot pressing method made to heat and sinter in the state where it pressed after making another side contact the above-mentioned bonded surface] Or the above-mentioned ceramic paste can be applied to one of bonded surfaces, and it can join by the supersonic vibration method make supersonic vibration add and sinter in the state where it pressed after making another side contact the above-mentioned bonded surface.
[0019] Thus, if the junction unification of the tabular ceramic object 3 and the ceramic tubed base material 12 is carried out by sintering Between the tabular ceramic object 3 and a junction 10, since the thermal expansion difference between a junction 10 and the ceramic tubed base material 12 can be made very small, the heat stress concentrated on a junction 10 can be reduced sharply. And since there is little corrosion wear since a junction 10 is excellent also in corrosion resistance and plasma-proof nature, and there is little generating of wear powder, it does not have a bad influence on Wafer W.
[0020] As shown in the sample heating device 1 of this invention at drawing 1 or drawing 3 , furthermore, the inside of the principal surface of another side of a ceramic heater 3, The annular groove 2a which carried out the shape of a ring [**** / the shape of an outside of the above-mentioned ceramic tubed base material 12] along the perimeter edge of the junction 10 with the ceramic tubed base material 12 is engraved, about ten-junction surface area is enlarged and the chilling effect is heightened.
[0021] Since for the reason the heat stress concentrated on a junction 10 can be eased and generating of a crack can be prevented even if a heat cycle is repeatedly added [by generation of heat of a ceramic heater 2] in [temperature] 400 degrees C or more from a room temperature region, also in long-term use, airtightness is maintainable.
[0022] Even if it carries out the junction unification of a ceramic heater 2 and the ceramic tubed base material 12 by sintering, namely, between a ceramic heater 2 and junctions 10, And between a junction

10 and the ceramic tubed base material 12, a junction interface exists, respectively. [even if it forms a ceramic heater 1 and the ceramic tubed base material 12 by Ceramics Sub-Division of the same kind and makes a thermal expansion difference small by existence of these junction interfaces, since heat transfer is bad, heat stress concentrates, but] This invention is establishing an annular groove 2a in the perimeter edge of a junction 10 among the principal surfaces of another side of a ceramic heater 2, and enlarging surface area. Since the heat dissipation nature of the junction 10 is raised, even if heat stress concentrates on a junction 10, the size of the heat stress can be reduced, and generating of a crack can be prevented.

[0023] By the way, in order to acquire such an effect, the size of an annular groove 2a, especially depth T are important, and the effect which eases heat stress in less than 1mm since it is too shallow is small. For the reason, depth T of an annular groove 2a is good to be referred to as at least 1mm or more. For example, when the tabular ceramic object 3 and the ceramic tubed base material 12 are Ceramics Sub-Division which makes the main ingredients nitriding ARUNIUMU which has high-fever conductivity, the effect which eases heat stress most can be acquired because depth T of an annular groove 2a shall be 4-6mm. However, since it will become difficult to make temperature distribution of the installation side 5 uniform while the intensity of a ceramic heater 2 falls greatly if depth T of an annular groove 2a becomes larger [the thickness of the tabular ceramic object 3] than 1/2mm, a maximum is good to be referred to as 1/2mm or less of the thickness of the tabular ceramic object 3.

[0024] Moreover, the width L of an annular groove 2a is good to set up in 1-25mm. This is because the effect which it is filled with heat in an annular groove 2a also considering depth T of an annular groove 2a as 1mm or more since width L is too narrow, and eases heat stress is small in less than 1mm, and when it becomes conversely larger than 25mm, it is because there is a possibility of producing variation in the temperature distribution of the installation side 5.

[0025] Furthermore, what formed the bottom as shown in drawing 1 from a viewpoint which prevents generating of a crack in the shape of a curved surface is desirable, and the cross-sectional form of an annular groove 2a is the curvature radius R1. The range of 0.5-12.5mm is good. As a method of forming such an annular groove 2a, it can form by using processing methods, such as grinding, a shot blast, and ultrasonic processing.

[0026] In addition, although drawing 1 showed the example which formed the annular groove 2a among the principal surfaces of another side of a ceramic heater 2 along the perimeter edge of the junction 10 with the ceramic tubed base material 12 As shown in drawing 4 , only by meeting the inner circumference edge of the junction 10 with the ceramic tubed base material 12, what formed the annular groove 2a may be used, and although not illustrated further, what formed the annular groove 2a along the perimeter edge and inner circumference edge of a junction 10 with the ceramic tubed base material 12, respectively is available.

[0027] In this way if membrane formation, etching, etc. are processed to Wafer W using the sample heating device 1 of this invention Even if a heat cycle is repeatedly added in [temperature] 400 degrees C or more from a room temperature region, it is not hurt in the junction 10 of a ceramic heater 2 and the ceramic tubed base material 12. Since the temperature distribution of the installation side 5 can always be kept uniform, over a long period of time, it is stabilized and high-precision membrane formation and high-precision etching can be given.

[0028] Next, other embodiments of this invention are explained.

[0029] Drawing 5 is the sectional view showing other examples of the sample heating device 1 of this invention, forms the truncated cone-like height 2b in the central part of the principal surface of another

side of the tabular ceramic object 3 which constitutes a ceramic heater 2, and carries out the junction unification of the ceramic tubed base material 12 airtightly by sintering at this height 2b.

[0030] Thus, since the effect same with having enlarged surface area of the perimeter edge of a junction 10 by forming Height 2b in the central part of the principal surface of another side of the tabular ceramic object 3 is acquired and the heat dissipation nature of a junction 10 can be raised, The heat stress concentrated on a junction 10 can be eased, and generating of a crack can be prevented.

[0031] Since [however,] the difference of the thickness of the central part and the thickness of a periphery part in the tabular ceramic object 3 will become large too much if the effect that height Q of Height 2b eases heat stress in less than 1mm is small in the case of this structure and it becomes higher than 10mm conversely Even if it adjusts the resistance of the resistance heating element 4 currently laid underground into the tabular ceramic object 3 in the central part and a periphery part, it is difficult to make temperature distribution of the installation side 5 uniform. For the reason, height Q of Height 2b is good to prepare in 1-10mm.

[0032] Moreover, it is good to form in the shape of [smooth] a curved surface from a viewpoint which prevents generating of a crack, and the edge of the principal surface of another side of the tabular ceramic object 3 and the side of Height 2b is the curvature radius R2. It is desirable to be referred to as 0.3mm or more.

[0033] Thus, although drawing 5 showed the example in which the truncated cone-like height 2b was formed in the central part of the principal surface of another side of the tabular ceramic object 3 As shown in drawing 6 , the height 2b of the shape of a ring which agreed with the form of the junction of the ceramic tubed base material 12 is formed in the central part of the principal surface of another side of the tabular ceramic object 3. To this height 2b, even if it carries out the junction unification of the ceramic tubed base material 12 by sintering, the airtightness of a junction 10 is maintainable over a long period of time.

[0034] (Work example 1) in order to check the effect by forming an annular groove 2a along the perimeter edge and/or inner circumference edge of a junction 10 with the ceramic tubed base material 12 here After heating until it installs the conventional sample heating device 31 without an annular groove 2a in the vacuum processing room 20 and the mean temperature of a ceramic heater 32 becomes 800 degrees C, By measuring ten temperature of the installation side 35 with an infrared thermometer, measuring temperature distribution, and conducting simulation analysis which used the finite element method based on this temperature distribution The inner circumference edge of the junction 10 with the sample heating device 1 which formed the annular groove 2a along the perimeter edge of the junction 10 with the ceramic tubed base material 12, the sample heating device 1 which formed the annular groove 2a along the inner circumference edge of the junction 10 with the ceramic tubed base material 12, and the ceramic tubed base material 12 And the heat stress generated in the junctions 10 and 40 of the tabular ceramic objects 3 and 33 and the ceramic tubed base materials 12 and 42 was respectively analyzed about the sample heating device 1 which formed the annular groove 2a along the perimeter edge, respectively, and the conventional sample heating device 31 without an annular groove 2a.

[0035] The tabular ceramic objects 3 and 33 the size of a model In addition, 300mm of outer diameters, 15mm in thickness and the ceramic tubed base materials 12 and 42 consider it as the outer diameter of 50mm, and the thickness of 8mm. The tabular ceramic objects 3 and 33 and the ceramic tubed base materials 12 and 42 experimented in each supposing Ceramics Sub-Division to which the thermal conductivity at 25 degrees C makes the main ingredients alumimium nitride 64 W/mk and whose

thermal conductivity at 800 degrees C are 32 W/mk.

[0036] Each result is as being shown in Table 1 - 3.

[0037] As for it, these results turn out that the heat stress generated in a junction 10 can be greatly eased by forming an annular groove 2a along the inner circumference edge and/or perimeter edge of a junction 10 with the ceramic tubed base material 12. And it is in the tendency for heat stress to become small, so that depth T of an annular groove 2a becomes deep, and the depth of an annular groove 2a is understood that the deeper one is good.

[0038] Furthermore, it turns out that the direction established in the perimeter edge can make heat stress small rather than establishing an annular groove 2a in the inner circumference edge of the junction 10 with the ceramic tubed base material 12.

[0039] Next, in order to check the effect when changing the width L of an annular groove 2a, depth T of the annular groove 2a was fixed to 4mm, and change was not looked at by heat stress when analyzed with the finite element method about heat stress when the width L of an annular groove 2a is 2mm smaller than 5mm and 10 conversely largermm than 5mm.

[0040] It turns out that heat stress can be made small by the heat stress which acts on a junction 10 originating especially in depth T of an annular groove 2a greatly, and forming an annular groove 2a from this.

[0041]

[Table 1]

セラミック筒状支持体との接合部の外周縁に沿って環状溝を形成したもの

溝深さ (mm)	接合部に発生する熱応力 (kgf/mm²)
0	15
1	12
2	9.6
4	7.2
6	2.4

※ 溝の幅は5mmである。

[0042]

[Table 2]

セラミック筒状支持体との接合部の
内周縁に 沿って環状溝を 形成したもの

溝深さ (mm)	接合部に発生する熱応力 (kgf/mm²)
0	15
1	10.8
2	9.6
4	8.4
6	7.2

※ 溝の幅は5mmである。

[0043]
[Table 3]
セラミック筒状支持体との接合部の 内周縁
及び 外周縁に 沿って環状溝を 形成したもの

溝深さ (mm)	接合部に発生する熱応力 (kgf/mm²)
0	15
1	10.8
2	10.2
4	7.2
6	7.2

※ 溝の幅は5mmである。

[0044] Next, in order to check the effect in a work example 1, the sample heating device 1 which formed the depth T1mm annular groove 2a along the perimeter edge of the junction 10 with the ceramic tubed base material 12, and the conventional sample heating device 31 without an annular groove 2a are actually made as an experiment, respectively. (Work example 2) These sample heating devices 1 and 31 were installed in the vacuum processing room 20, the heat cycle which repeats heating and cooling for ceramic heaters 2 and 32 in [temperature] 800 degrees C from a normal temperature region (25 degrees C) was performed, and the experiment checked about the airtightness of junctions 10 and 40 with helium leak detector was conducted. in addition, thermal conductivity [in / each / in the tabular ceramic objects 3 and 33 and the ceramic tubed base materials 12 and 42 which constitute ceramic heaters 2 and 32 / 25 degrees C] -- 64 W/mk -- and While the thermal conductivity at 800 degrees C formed by high purity alumimium nitride Ceramics Sub-Division which is 32 W/mk, what also formed the size of ceramic

heaters 2 and 32 and the ceramic tubed base materials 12 and 42 with the same size as a work example 1 was used.

[0045] as a result, [the conventional sample heating device 31 without an annular groove 2a] A crack occurs in about 10 times of heat cycles in the junction 40 of a ceramic heater 32 and the ceramic tubed base material 42. It was able to check that a crack was not looked at by the junction 10 of a ceramic heater 3 and the ceramic tubed base material 12 in 600 heat cycle examinations, but the sample heating device 1 of this invention which formed the annular groove 2a had sufficient airtightness to airtightness having fallen.

[0046]

[Effect of the Invention] As mentioned above, the ceramic heater which has the electric supply terminal which according to this invention made one [which lays a resistance heating element underground] principal surface of the tabular ceramic object the installation side of the sample, and was electrically connected with the above-mentioned resistance heating element in the principal surface of another side, In the sample heating device which consists of a ceramic tubed base material which junction unification is airtightly carried out by sintering of in the principal surface of another side of said ceramic heater so that the above-mentioned electric supply terminal may be surrounded, and installs the above-mentioned ceramic heater in the vacuum processing interior of a room [engrave / along the perimeter edge and/or inner circumference edge of a junction with the above-mentioned ceramic tubed base material / among the principal surfaces of another side of the above-mentioned ceramic heater / an annular groove] Or the height is formed in the central part of the principal surface of another side of the above-mentioned ceramic heater. since the ceramic tubed base material was joined to this height and the heat stress which makes small the temperature gradient in the junction of a ceramic heater and a ceramic tubed base material, and acts on a junction can be reduced, maintaining the airtightness which did not produce a crack in a junction and was excellent cuts. [and the ceramic heater exposed to the vacuum processing interior of a room, a junction, and a ceramic tubed base material] Since all are precise, and it consists of Ceramics Sub-Division excellent in heat resistance, corrosion resistance, and plasma-proof nature, while it is long lasting, it does not have a bad influence on samples, such as a wafer, and neither membrane formation accuracy nor etching accuracy is degraded further.

[Translation done.]